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ASHRAE and residential ventilation

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ASHRAE, the American Society of Heating, Refrigerating, and Air-conditioning Engineers, is the world leader in the field of heating, ventilating, air-conditioning and refrigeration (HVAC&R). ASHRAE has recently released a new residential ventilation standard reflecting minimum requirements for homes. They have also released a top ten list of things that homeowners should be aware of to protect their indoor environment. This article provides a summary of what homeowners and HVAC&R professionals should know regarding residential ventilation.

Keywords: Residential Ventilation, Standards, Indoor Air Quality

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Introduction

As HVAC&R professionals, our major concern is the engineering of indoor environments. Most of our industry's emphasis is on providing comfort conditioning, but as professionals, health and safety must also be a primary concern. For indoor environments, where concentrations of many pollutants can be two to at least five times greater than in outdoor air (Wallace, 1987), source control and ventilation are key control means. People spend, on average, nearly 90% of their time indoors (Klepeis et al., 2001) with the majority of that time in their homes. These facts taken together would suggest that residential ventilation ought to have a large emphasis in ASHRAE. Viewed in a historical context, residential ventilation has been a high priority for society and then for the profession; ASHRAE ventilation standards have continued to evolve in the last half of the 20th century.

More recently ASHRAE has demonstrated significant leadership in the residential area. ASHRAE has produced several important documents including guidelines in Chapter 26 of the Handbook of Fundamentals (ASHRAE 2001a), ASHRAE 62.2-2003, and, most recently, a top ten list of things homeowners should do. The purpose of this article is to look at the existing guidance and take a snapshot of residential ventilation from the perspective of what it means to occupants and HVAC professionals.

Historical Perspective

Intuitively, most of us understand that the purpose of ventilation is to dilute indoor contaminants[2]. As engineers, we need to determine how much air is necessary to reduce concentrations of these contaminants to desired levels. Such an approach assumes some sort of scientific underpinnings. The science of ventilation and indoor air quality dates back to the 17th century with work credited to Mayow (Foster 1901). However, concerns about "bad air" go back much further than that. One of the earliest reasons to ventilate the indoor environment—and one that is still with us today—is to remove the products of combustion used for heat, light, or cooking. Early man undoubtedly learned quickly that if he brought fire inside he needed to get the smoke out. The specific driver for ventilation has changed over time, but has usually been associated with a particular set of pollutant sources that are causing health or comfort problems. Historically, these sources have been heat, combustion, people and their activities, and the buildings themselves.

Throughout time, man has either put up with the existing indoor environment or made changes to improve it. Early living quarters offered a rudimentary level of protection from the elements, roaming creatures and foes. Caves, overhangs, and natural materials (e.g., trees, stone, clay, animal skins) were used to build shelters. These shelters had sturdy doors and small openings to the outside to prevent any unwanted creatures or enemies from coming in. This meant that homes were often smoky and it was difficult to intentionally bring in significant outdoor air to dilute any indoor pollutants. Sanitary conditions were often quite poor, which resulted in both direct contamination as well as a growth medium for microorganisms.

Looking in the archeological records, we can find several examples of how houses were built to accommodate ventilation and improve indoor air quality. Various approaches were developed to deal with the use of fires inside dwellings. In 4000-5000 BC, the Banpo villagers in China incorporated chimneys into their homes (Li and Jones 2000). The Romans put a vent hole in the middle of their houses' flat roofs to vent smoke out of the living quarters. The basket weaver's pit houses found in Mesa Verde National Park, circa 750 AD, use this same approach (Wenger and Wilson 1991). Teepees, with their vent holes at the top and openings around the

[2] In this context internal gains can sometimes be a "contaminant" and ventilation for cooling is then an important consideration.

bottom were designed to accommodate fires and ventilation. The teepee doors could be positioned to control airflow.

The Romans developed the hypocaust heating system for heating larger buildings. The hypocaust was a pre-cursor to the heating and ventilation system integrated into Britain's parliament buildings in the late 1800's. Outside air enters the hypocaust and gains heat from a fire and then is channeled through an under-floor series of channels, up through channels in the walls and is vented to the outdoors. The systems built in the late 1880's use a similar approach but also supply outside air to the building. Outside ventilation air is pulled over steam pipes in a heating chamber and ducted into the building. Exhaust openings in the upper reaches of the building provide a stack effect to pull air through the building.

In 1631, after finding that indoor conditions were causing health problems, King Charles I, in what may have been the first ventilation code, decreed that the ceilings in houses must be ten feet high or greater and that windows must be higher than their width to allow for ventilation. These improvements were slowly implemented into the British building stock. Implementation was hastened only when the great London fire of 1666 destroyed many of the inadequate houses and made way for construction of larger, better ventilated houses with chimneys and large windows. (NY 1923) This trend towards better air quality, however, was suddenly thwarted and possibly reversed when citizens decided to board up their windows to avoid the chimney and window taxes of the early 1700's.

A More Modern Perspective

A look at past ventilation and indoor air quality issues provides insight into today's issues that might otherwise be overlooked. Ventilation is about health and most regulations, recommendations and requirements have been driven by such acceptability concerns. Not surprisingly, it is ASHRAE's position to consider health impacts when setting criteria for indoor environments (ASHRAE 2001b).

Because of the effects it has on health, comfort, and serviceability, indoor air quality in our homes is an increasing concern to many people. According to the American Lung Association, elements within our homes have been increasingly recognized as threats to our respiratory health. The Environmental Protection Agency lists poor indoor air quality as the fourth-largest environmental threat to our country. Asthma is the leading serious chronic illness of children in the U.S. (ALA 1999) Moisture-related construction defects and damage is on the increase in new houses (Claims 1999). Improved residential ventilation can reduce many of these indoor air quality problems.

While increasing ventilation rates is often the *first* line of defense, source control has always been recognized as the *best* line of defense. The history of combustion moving from open and dirty combustion to sealed, clean combustion is an example of this. ASHRAE's position follows this trend by stating that source control is the most effective and preferred method of providing good indoor air quality in most cases.

By the middle of the 20th Century, society made major strides in controlling the sources of poor indoor air quality. Combustion appliances were becoming better. Many of the key infectious diseases had been eliminated as a major concern by improved sanitation and hygiene as well as advances in the medical field (and a decrease in occupant densities). The best thinking of the time was that source control had been sufficiently successful that the biggest demand left for ventilation was to control the irreducible emissions of human bioeffluents.

In general, when proper sanitation is practiced, human bioeffluents are not health hazards, unless they are infectious or serve as a growth medium for microbiologicals. These bioeffluents do, however, produce odors that can be unacceptable. The emission and acceptability of human bioeffluents have been well studied. Since the middle of the 20th century, the general assumption has been that if one ventilates to control human odors, there will be enough ventilation to control the health effects from other contaminants. Implicit in this approach is that sufficient care has been taken to reduce emissions of any contaminant below the level of concern. Nevertheless at a low enough ventilation rate there will always be indoor air quality problems.

Today's Sources

Given the changes that have happened to buildings, materials, and systems over the last quarter of a century, it is important to revisit the assumption of adequate source control to see if it is still robust. Sources that in previous times may have been special cases or non-existent may be more common today. It is worth examining a few of the more common types of sources:

Combustion: Combustion of fossil fuels is still used for cooking, space heating, and water heating in many buildings. Most of this equipment is either sealed from the building or has venting that, when operating properly, removes the by-products, so that they do not mix with the indoor air. Consequently, there is usually no need to remove these combustion by-products by ventilating the building. However, backdrafting and malfunctioning equipment can introduce a combustion by-products source where none previously existed. Also, combustion by-products from other sources may still be found in the indoor environment. Examples of these other sources include environmental tobacco smoke, automobile exhaust (e.g., from attached garages), unvented heaters, decorative gas appliances, and unvented cooking equipment (e.g., no exhaust provided).

Microbiologicals: Historically, biological contamination was caused by poor hygiene and sanitation, and focused on disease. Ventilation reduced airborne disease transmission. Today's problems are more concerned with molds and other fungi that are growing on building materials and systems. Because it can increase the source as well as the removal rates, ventilation is, at best, moderately effective at reducing exposures to many airborne microbiologicals, but it can be part of the moisture balance that is critical to retarding or enhancing fungal growth. In terms of the amount of moisture in a building, ventilation can either be a source-control mechanism or a source, depending on the indoor and outdoor conditions.

Radon and Soil Gas: Buildings with substantial ground contact can be exposed to contaminants in soil gas through cracks or leaks. Such soil gas can contain toxics from pesticides or landfill or sewer gas, but the highest profile pollutant in this category is radon. It is believed that this radioactive noble gas can have long-term health impacts at very low concentrations. Source control measures such as differential pressure control and air tightening are far more effective mechanisms at controlling exposure to soil gas than is ventilation.

Particles: Particles can be generated by combustion (e.g., open fireplaces), can come from outdoors, or they can be generated from indoor sources such as people, pets, construction activities, or material degradation. Poor cleanliness can increase the concentration levels of airborne particles. Particles may be simple irritants, but can also cause allergic reactions (e.g., pet dander) or may contain toxic materials (e.g., lead). Depending on the source and size of particles, ventilation may not be particularly effective at reducing particle concentrations, but source control or filtration can be.

Volatile Organic Compounds: VOCs are ubiquitous in modern life. Products that emit VOCs include manufactured wood products, paints, stains, varnishes, solvents, pesticides, adhesives, wood preservatives, waxes, polishes, cleansers, lubricants, sealants, dyes, air fresheners, fuels, plastics, copy machines, printers, tobacco products, perfumes, cooking byproducts and dry cleaned clothes. Source control for many of these compounds requires changes in production or changes in how the associated product is used. While such source control is an on-going effort, modern buildings today are typically filled with a low-level of a broad spectrum of VOCs that must be controlled by ventilation.

ASHRAE's Residential Ventilation Standard: 62.2-2003

Before 1996 the only way ASHRAE standards addressed residential ventilation was as a small part of its broader ventilation standard, standard 62. In 1996, ASHRAE recognized that there was a need to have a separate standard for residential ventilation and formed a committee to do just that. Seven years later, ASHRAE approved Standard 62.2-2003. As a standard intended for use in regulation, 62.2 was crafted to describe the minimum requirements necessary to provide minimally acceptable indoor air quality for typical situations. The standard is a trade-off between dilution ventilation and source control and attempts to be as flexible as the consensus process allows.

Standard 62.2 is not an overly complex or long document. It is applicable to both new and existing homes, including all single-family homes and small multifamily ones. Its major requirements are listed below:

- With some exceptions, the standard requires whole-house mechanical ventilation. For a typical house, the required ventilation rate is about 50 cfm, but it increases with house size. The standard allows (and provides guidance for) flexibility in ventilation system selection (e.g., continuous or intermittent; supply or exhaust; with or without heat recovery).
- Mechanical exhaust (i.e., to outdoors) is required in kitchens. The basic requirement is that a user-operable vented range hood must exhaust at least 100 cfm of air. To accommodate the wide range of kitchen configurations in the market, the standard includes an alternative of 5 kitchen air changes per hour of (continuous or intermittent) exhaust without any requirements regarding location within the kitchen.
- Mechanical exhaust is required in bathrooms, but not in rooms such as toilet rooms, laundry rooms, lavatories, and utility rooms. The basic requirement is for a user-operable fan of at least 50 cfm. A continuously operating exhaust fan of 20 cfm may be used as an alternative.
- The fans or fan systems required to meet the previous requirements must meet specific airflow and noise performance levels.
- Combustion appliances must follow applicable codes. For a narrow set of circumstances, vented combustion equipment must be checked for backdrafting/spillage. Otherwise, there are no requirements specific to combustion equipment, vented or unvented.
- When air handlers or return ducts are in an attached garage, the duct system must be tested to meet air tightness specifications.
- Good particle filtration is required upstream of air handling components. (The minimum filtration requirement is easily met, but is better than the fiber filters most commonly used.)

There are a few other requirements, which are either minor, codify general practice, or are relevant only to specific situations.

ASHRAE'S Top 10 - How to Ensure Good Indoor Air Quality

Professionals are bound by the ethics of their profession and that includes making appropriate use of professional standards. HVAC professionals, therefore, must consider standards such as 62.2 when dealing with residential ventilation. Best practices, by comparison, are things to consider and to strive for, but go beyond the minimum standard of care. Current ASHRAE policy is that standards such as 62.2 represent minimum requirements and are not necessarily best practice.

ASHRAE has generated the following list of the top ten things that homeowners can do to get good indoor air quality. This list goes beyond the requirements of Standard 62.2 and includes recommendations from ASHRAE's Handbook of Fundamentals and also from the cognizant technical committee (TC 5.12):

1. Fossil-fuel-fired water heaters and furnaces should use sealed-combustion or be power-vented. When natural-draft appliances must be used, they should be tested for proper venting and should be located outside the occupiable space when possible.

2. Vent bathrooms, kitchens, toilets, and laundry rooms directly outdoors. Use energy efficient and quiet fans.

3. Avoid locating leaky furnaces, air conditioners, and ductwork in garages or other spaces where they can inadvertently draw contaminants into the house. Install a door closer to ensure doors between houses and garages do not accidentally stay open. Apply weather-stripping to the doors to reduce airborne contaminant transport around the door edges. If ducts must pass through a garage or other potentially polluted space, seal the ducts well to avoid entrainment of polluted air.

4. Properly vent fireplaces, wood stoves, and other hearth products; use tight doors and outdoor air intakes for these products when possible.

5. Put a good particle filter or air cleaner in your air handling system to keep dirt out of the air and off of your ductwork and heating and cooling components. Maintain it or replace it regularly as needed.

6. Vent clothes dryers and central vacuum cleaners directly outdoors.

7. Store volatile compounds such as paints, solvents, cleaners, and pesticides out of the occupiable space and away from ventilation air intakes.

8. Minimize or avoid altogether unvented combustion sources such as candles, cigarettes, indoor barbecues, decorative combustion appliances, or vent-free heaters.

9. Distribute a minimum amount of outdoor air throughout the home, using whole-house mechanical ventilation.

10. Provide operable windows or additional mechanical ventilation to every space to accommodate unusual sources or high-polluting events, such as the use of home cleaning products, and hobby activities.

The following examines the top-ten list in more detail to determine what is specified in Standard 62.2, what goes beyond it, and what a professional should do.

1. Vented Combustion Equipment

Over the past few decades, combustion appliances have greatly improved in quality and energy efficiency; they are often the first choice for space and water heating. However, spillage of combustion byproducts from natural draft appliances to indoors remains as a particular concern, because it can represent a significant health and life safety hazard. These appliances, which are a holdover from previous generations of equipment, rely on excess waste heat to power a flue and rely on a leaky building envelope to supply make-up air.

To minimize the risk of spillage, natural draft appliances should be located outside the pressure boundary of the home. However, Standard 62.2 allows natural draft appliances inside the home, but under some circumstances requires testing to reduce the potential risk of spillage. Use properly installed sealed-combustion or power-vented water heaters and furnaces to keep combustion byproducts out of the living space.

2. Local Exhaust

Because of their function, several rooms in a home are expected to have high concentrations of contaminants: kitchen, bathroom, toilet, laundry room, lavatory, utility room. These “wet rooms” are best served by having a local exhaust system that removes contaminants before they can migrate away from the source.

Standard 62.2 requires local exhaust only in kitchens and bathrooms. It also requires that these fans be somewhat quiet (1.0 sone or less for continuous ventilation fans, 3.0 sones or less for intermittent fans with less than 400 cfm [200 l/s] maximum airflow), but it does not provide energy efficiency requirements. Thus, good practice is to install low-sone, energy-efficient exhaust fans so that they are used more and are less expensive to operate.

Most exhaust fans used today are the less expensive models, which are noisy and inefficient. Such fans also tend to have a shorter lifetime. Noisy fans will get used less and inefficient fans will cost more to operate.

3. Garages and Other Contaminated Spaces

The air in garages is typically polluted. In addition to car (or other engine) exhaust, there can be a variety of volatile compounds stored there. One should make efforts to isolate the garage from the living space to prevent migration of these contaminants.

The most important aspect of isolating the space is to keep the air distribution system out of it. Leaks in the return side of the system can suck in garage contaminants and have been linked to poisoning incidents. Supply side leaks can cause problems by pressurizing the garage and inducing flow into the living space.

Standard 62.2 allows return ductwork in the garage, but requires that it meet a tightness limit. It is best to keep all of the air distribution system within the pressure boundary of the home. Systems that do pass through contaminated spaces should be checked for duct leakage and leaky ducts should be sealed.

4. Hearth Products

Many people like the look and feel of hearth products. Such products can range from an open fireplace to a highly engineered wood stove. While solid-fuel appliances share similarities with gas and oil appliances, the pattern of firing can be quite different. Smoldering fires coupled with backdrafting chimneys can be dangerous.

Standard 62.2 allows hearth products inside the pressure boundary, but under certain circumstances requires a test be done to reduce the risk of spillage. The best way to prevent hearth products from becoming indoor sources is to effectively move them out of the pressure boundary by the using, for example, tight fitting doors and outdoor air intakes.

Explosion dampers on hearth products can sometimes leak when they do not fully reseat after being activated. Therefore, it is good practice to periodically check that these dampers are closed, so that combustion byproducts cannot inadvertently leak indoors.

5. Particle Filtration

Particulate matter can be an indoor air quality problem in several ways. Fine and ultrafine particles can cause lung disease; pollens and dander can cause allergies, and deposited particulate matter (i.e., dust) can become a growth medium for mold and other fungi. In HVAC systems, dust buildup can reduce the efficiency of system components and, by becoming a growth medium, become a source of microbial contamination.

Fortunately, particulate matter is one of the easiest pollutants to remove from indoor air. Particle filters exist in many configurations. Standard 62.2 requires that all HVAC components have a good particle filter in front of them to keep them from become contaminant sources. Running air handlers continuously and using better particle filters can achieve improved indoor air quality. Care must be taken to select filters and efficient air handlers and duct systems that maintain proper flow and pressure drops in the air distribution system.

6. Clothes Dryers and Central Vacuum Cleaners

Clothes dryers and central vacuum systems have contaminants in their exhaust stream that can cause indoor air quality problems. Both contain particulate matter that is sometimes too small to be caught in the appliance filter, but can cause lung disease. Clothes dryer exhaust contains laundry product residues and moisture.

Standard 62.2 requires all clothes dryers to be vented directly outdoors, but does not address central vacuum systems. To reduce particulate levels and other contaminants, central vacuum cleaners should also be vented directly outdoors.

7. Toxic Compound Storage

Most homes store a variety of toxic compounds (e.g. cleaning solvents, paints or finishing compounds, pesticides) in the conditioned space. Many of these compounds are volatile or semi-volatile and can become contaminant sources.

Use of these products is typically a *high-polluting event* as defined in Standard 62.2. They should be used with increased ventilation such as through open windows or additional exhaust fans. Storage of these products is not mentioned in the standard, but to the extent possible this should be done outside the pressure boundary of the home (e.g., in the garage), and away from ventilation air intakes.

8. Unvented Combustion

Historically, because of the large amount of contaminants that can be produced, unvented combustion has been one the most important drivers for ventilation. While technology has improved the performance of some specific appliances, unvented combustion should be avoided. Many jurisdictions prohibit various forms of unvented combustion appliances.

With the exception of gas cooking equipment, most unvented combustion that takes place is an occupant choice rather than something designed into the home. Contaminants from gas cooking are normally taken care of by vented range hoods, but contaminants from smoking, indoor barbeques, and candles are not.

ASHRAE Standard 62.2 does not consider most of these unvented combustion sources in setting its minimum rates. It presumes that when occupants choose to undertake these often high-polluting activities, they will provide additional ventilation. Several kinds of indoor air quality problems can result when occupants do not provide additional ventilation in the presence of unvented combustion. Best practice is to avoid unvented combustion as much as possible.

9. Minimum Mechanical Ventilation Rates

The previous items were all about reducing the risk from specific contaminant types. Not all contaminants are known and not all contaminants can be kept out of the air. There is, therefore, a need for a certain amount of dilution ventilation.

Occupants tend to be rather poor ventilation sensors and cannot do a very good job of determining whether the minimum ventilation rates are being met or not. For this reason, mechanical ventilation is preferable to windows or other systems that require occupant control or provide unpredictable amounts of ventilation.

The mechanical ventilation rates in Standard 62 are typically 40 to 70 cfm, depending on the size of the home. In mild climates and other special circumstances, Standard 62.2 allows natural ventilation to be used instead of mechanical ventilation.

While not required in Standard 62.2, air distribution can be important. Ideally, fresh air should be supplied to every occupiable room. Houses whose air handlers operate frequently can come pretty close to that, but in houses without central air systems, there can be large differences in contaminant concentrations from room to room.

10. Extra Ventilation Capacity

There will always be times during the normal operation of a home where contaminant sources will be substantially above average levels. Occupants engage in a variety of activities from parties to painting. It is important to have the capacity to increase ventilation for any kind of high-polluting activity.

Unlike the minimum ventilation rates, occupants are usually aware that they need additional ventilation when undertaking these more unusual activities. Thus, windows can usually meet this need. For rooms that do not have windows or the ventilation through these windows is not sufficient, or because of comfort issues, additional mechanical ventilation should be installed and used.

Standard 62.2 requires that habitable rooms have windows or mechanical systems to meet this need. The window requirement is the same as that already existing in most building codes and thus is not onerous.

11. Water Intrusion Control

The astute reader will have noticed that this is the eleventh topic in a list of ten. The reason for this is that liquid water is not directly an indoor air quality problem. It can, however, create one if not properly managed. When liquid water is present, it can encourage the growth of molds and other fungi. The severity of the associated problem varies greatly depending on where it is happening.

Mold on a hard surface like bathroom tile is easily seen and easily cleaned. On the other hand, water inside a building envelope component, whether from condensation, rain penetration or leaky plumbing, can be difficult to detect and can lead to significant problems that include, but go beyond, indoor air quality.

Water intrusion is not fundamentally an HVAC problem. It cannot be reasonably dealt with by ventilation and is not normally in the purview of HVAC professionals. Homeowners, however, should be aware that leaky pipes, poor flashing, poor site drainage or poor envelope design can result in water getting to where it does not belong and causing failures in building systems.

What This Means to the HVAC&R Professional

ASHRAE Standards can become codes. If they do, they have the force of the law behind them and become the minimum thing you must legally do. Even if these Standards do not become code, HVAC&R professionals have a professional obligation to use them when applicable. Following standards usually has an associated cost, but offers benefits to the user and some level of protection for the designer.

There is obviously a cost in meeting a standard such as 62.2. There can be a first cost impact during construction or renovation of a home in order to meet it. Reasonable estimates are in the range of $200, although the real answer depends on the starting point; it is always possible to design the system to cost much more.

There can also be an operating cost impact because of the need to run fans and to condition ventilation air. Again, the actual costs will depend on the basis for comparison. A drastically under-ventilated house would show a significant cost penalty, but a house that was over-ventilated could show a savings.

The purpose of Standard 62.2, however, is not to minimize first cost or operating cost, but to provide the necessary building service of providing minimum acceptable indoor air quality. As HVAC&R professionals, we have an obligation to society to protect health and safety, whether it is a code or not. This ethic is what separates professionals from other kinds of interests.

Thus, a standard such as 62.2 is of great benefit to the HVAC&R professional and allied industries, because it defines a demonstrable set of criteria for acceptability. The user of the standard can show a client or a court that he has done what the profession says is needed and thus has met his professional responsibility. The clients and occupants have some level of assurance that the building will perform and the professional has some level of protection by doing his due diligence.

Another benefit to a standard such as 62.2 is to provide a level playing field. If all those competing for a particular job are required to meet 62.2, one cannot gain a competitive advantage by providing poor indoor air quality and/or insufficient ventilation. Ideally, those who promote unacceptable ventilation solutions would also be eliminated from the profession rather than reducing the image of the profession.

ASHRAE's top ten goes beyond the minimum requirements of Standard 62.2 and thus represents a set of value-added options that can often be achieved for little incremental cost. While standards allow competitors to have a level playing field, these kinds of value added options allow competition based on superior performance rather than on cost alone.

Summary

In the last quarter of a century, the western world has become increasingly aware of environmental threats to health and safety. During this period, people psychologically retreated away from outdoors hazards such as pesticides, smog, lead, oil spills, and dioxin to the seeming security of their homes. However, the indoor environment may not be healthier than the outdoor environment, as has become more apparent over the past few years with issues such as mold, formaldehyde, and sick-building syndrome. While the built human environment has changed substantially over the past 10,000 years, human biology has not; poor indoor air quality creates health risks and can be uncomfortable. The human race has found, over time, that it is essential to manage the indoor environments of their homes.

ASHRAE has long been in the business of ventilation, but most of the focus of that effort has been in the area of commercial and institutional buildings. Residential ventilation was traditionally not a major concern because it was felt that, between operable windows and envelope leakage, people were getting enough outside air in their homes. In the quarter of a century since the first oil shock, houses have gotten much more energy efficient. At the same time, the kinds of materials and functions in houses changed in character in response to people's needs. People became more environmentally conscious and aware not only about the resources they were consuming but about the environment in which they lived.

All of these factors contributed to an increasing level of public concern about residential indoor air quality and ventilation. Where once there was an easy feeling about the residential indoor environment, there is now a desire to define levels of acceptability and performance. Many institutions--both public and private--have interests in Indoor Air Quality (IAQ), but ASHRAE, as the professional society that has had ventilation as part of its mission for over 100 years, is the logical place to provide leadership.

This leadership has been demonstrated most recently by the publication of the first nationally recognized standard on ventilation in homes, ASHRAE Standard 62.2-2003, which builds on work that has been part of ASHRAE for many years and will presumably continue.

Homeowners and occupants, which includes virtually all of us, will benefit from the application of Standard 62.2 and use of the top ten list. This activity is exactly the kind of benefit to society that the founders of ASHRAE envisioned and is consistent with ASHRAE's mission and vision. ASHRAE members should be proud of their Society for taking leadership in residential ventilation.

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